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Two species of the genus *Strobiliger*a (Caenogastropoda: Triphoridae) with a multispiral protoconch in Southeastern Brazil

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Abstract: The genus *Strobiliger*a Dall, 1924, sometimes treated as a synonym of *Inella* Bayle, 1879, included up to now species geographically restricted to the North Atlantic Ocean, usually occurring at great depths. The present study records the genus *Strobiliger*a in the South Atlantic Ocean, with the recognition of two species in Southeastern Brazil. The shell of *Strobiliger*a *delicata* sp. nov., which has a white teleoconch and a light brown protoconch, is very similar in general coloration to the shells of *Strobiliger*a *georgiana* (Dall, 1927) comb. nov. and *Strobiliger*a *indigena* (Dall, 1927) comb. nov., both from the southeastern coast of the United States. However, *S. delicata* differs from those species in shell shape, number of axial cords on the teleoconch and earlier development of the adapical spiral cord of the teleoconch. *Strobiliger*a *inaudita* (Rolán and Lee, 2008) comb. nov., previously known from the southern coast of the United States, is diagnosed by a teleoconch with adapical and abapical spiral cords tinted with brown and white nodules, and by a completely white median spiral cord. *Strobiliger*a *delicata*, *S. inaudita*, *S. georgiana* and *S. indigena* have multispiral protoconchs, similar to those of their congeneric species from the East Atlantic (Europe and North Africa) and Mediterranean. Other species of *Strobiliger*a from the Caribbean and neighboring areas, including the type species *Triforis ibex* Dall, 1881, have a paucispiral protoconch. Hence, the generic allocation of species with a multispiral protoconch to *Strobiliger*a cannot be considered definitive, and should be confirmed by subsequent anatomical studies of species with different modes of development.

Key words: taxonomy; Mollusca; *Inella* group; Atlantic Ocean; microgastropods

Triphoridae is a large family of marine microgastropods, comprised of sponge feeders (Marshall 1983). They are usually recognized by the presence of a left-coiled shell in most species, besides a large variation in radular morphology. Despite being much more diverse in the Indo-Pacific (Albano *et al.* 2011), several authors (*e.g.,* Rolán and Fernández-Garcés 2008) have also reported a high number of species in the Atlantic Ocean.

Our knowledge of Triphoridae in Brazil has recently increased, with the description of a deep-sea species from the Canopus Bank (Simone 2006), the review of the genus *Metaxia* Monterosato, 1884 (Fernandes and Pimenta 2011), and the study of Triphorinae from the Vitória-Trindade Seamount Chain (Fernandes *et al.* 2013). The number of reported species of Triphoridae from Brazil has been increased to 26, and many remain to be described or reported (Fernandes *et al.* 2013).

Following the synonymy of Iniforinae with Triphorinae by Marshall (1983), Triphoridae has two subfamilies: Metaxiinae, composed only of dextral species, and Triphorinae, which includes the sinistral species. However, Marshall (1983) created the concept of the "*Inella* group" in Triphorinae and suggested that it could subsequently be worthy of subfamily status. This group can be recognized by a tendency for simultaneous development of the three spiral cords of the teleoconch (although the adapical one is usually weaker), an embryonic shell with cruciform tubercles, and the presence of a smooth spiral zone on the larval shell (Marshall 1983). The latter two features are present only in species with a multispiral protoconch (indicative of planktotrophic development).

In the "*Inella* group", *Strobiliger*a Dall, 1924 was considered to be either a valid genus (Bouchet 1985, Bouchet and Warén 1993) or a possible synonym of *Inella* Bayle, 1879 (Rolán and Fernández-Garcés 2008). Currently, *Strobiliger*a contains five species (Dall 1924, Gofas 2013), all of which are restricted to the North Atlantic. These species have different types of larval development: those from the Mediterranean and East Atlantic (Europe and North Africa) are exclusively of the planktotrophic type (multispiral protoconch), whereas those recorded from the Caribbean and neighboring areas are of the lecitotrophic type (paucispiral protoconch). Based on the assumption that different modes of larval development, thus different types of protoconch, can coexist in the same genus (Bouchet 1990), Bouchet (1985) and Bouchet and Warén (1993) included species with a multispiral protoconch in *Strobiliger*a, although the type species of the genus has a paucispiral protoconch. This study reports the discovery of two species of *Strobiliger*a, both with multispiral protoconch, in the South Atlantic, more precisely in Southeastern Brazil.

MATERIALS AND METHODS

Taxonomic identifications were based on conchological comparisons using stereomicroscope and scanning electron microscope (SEM) images. The whorl-counting procedure was based on Leal (1991) and the distinction between embryonic shell and larval shell follows Fernandes *et al.* (2013). General terminology was based on Marshall (1983), except in relation to the spiral cords, as we prefer to designate them as adapical, median, abapical, and sutural cords. In the lists of material examined, the number of shells in each lot is indicated in square brackets. All material examined consisted of empty shells.

Abbreviations used: (AMS) Australian Museum, Sydney, Australia; (BGR) Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, Germany; (BMSM) The Bailey-Matthews Shell Museum, Sanibel, Florida U.S.A.; (FLMNH) Florida Museum of Natural History, Gainesville, Florida U.S.A.; (HAB) "Projeto Habitats – Heterogeneidade Ambiental da Bacia de Campos" (Habitats Project), carried out by CENPES/PETROBRAS, Research Vessel Miss Emma McCall coll.; (IBUFRJ) Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; (MD55) French-Brazilian Expedition MD55, Research Vessel Marion-Dufresne coll., May-June/1987; (MNHN) Muséum national d'Histoire naturelle, Paris, France; (MNRJ) Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; (MORG) Museu Oceanográfico do Rio Grande, Rio Grande, Brazil; (MZSP/MZUSP) Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil; (REVIZEE) "Programa de Avaliação do Potencial Sustentável de Recursos Vivos da Zona Econômica Exclusiva" (Program of Evaluation of the Sustainable Potential of Living Resources in the Exclusive Economic Zone), Central Score, carried out by Ministério do Meio Ambiente, Brazilian Government (REVIZEE C1, Oceanographic Ship Antares coll.); (USNM/NMNH) National Museum of Natural History, Washington, D.C., U.S.A.

RESULTS

Class Gastropoda Cuvier, 1795
Subclass Caenogastropoda Cox, 1960
Superfamily Triphoroidea Gray, 1847
Family Triphoridae Gray, 1847
Genus *Strobiligera* Dall, 1924

Diagnosis (adapted from Dall 1924; Bouchet 1985; Bouchet and Warén 1993): paucispiral or multispiral protoconch; paucispiral protoconch with the first whorl smooth and inflated, larger than subsequent whorl, which can have two spiral cords; multispiral protoconch with embryonic shell covered by cruciform or arrowhead-shaped granules, larval shell with two spiral cords and incomplete axial sculpture; teleoconch whorls usually with three spiral cords, the adapical one initially smallest but increasing in prominence throughout the teleoconch, rarely with only two evident spiral cords; radula with central, lateral and marginal teeth not differentiated, mainly with two elongated claw-shaped cusps.

Type species: *Triforis ibex* Dall, 1881. Original designation. Recent, Gulf of Mexico.

Strobiligera delicata Fernandes and Pimenta sp. nov.

(Figs. 1B–1K)

Type material: holotype: MNHN IM-2000-27528, MD55 sta. 54-CB93, 19°36′S, 38°53′W, 640 m, 30.v.1987. Paratypes: off Espírito Santo state: MNRJ 25955, MD55 sta. 41-DC73, 18°59′S, 37°48′W, 607–620 m, 27.v.1987 [1]; MNHN IM-2000-27529, MD55 sta. 43-CB77, 19°40′S, 37°48′W, 790–940 m, 27.v.1987 [3]; MZSP 114439, MD55 sta. 43-CB77, 19°40′S, 37°48′W, 790–940 m, 27.v.1987 [2]; off Rio de Janeiro state: MNRJ 25956, MD55 sta.65-CB106, 23°54′S, 42°10′W, 830 m, 02.vi.1987 [1].

Type locality: 19°36′S, 38°53′W, 640 m, off Espírito Santo state, Brazil.

Diagnosis: conical-fusiform shell; 3–3.5 protoconch whorls; adapical spiral cord of teleoconch becomes distinctive and nodulose at approximately the fourth or fifth whorl, reaching almost the same size as the abapical spiral cord between the eighth and tenth whorl; light brown protoconch, white teleoconch.

Description: shell sinistral, slender, narrow, conical-fusiform, rectilinear in profile, attaining up to 5.77 mm in length, 1.15 mm in width. Protoconch columnar, 0.40–0.50 mm in length, 0.34–0.39 mm in width, 3–3.5 convex whorls; embryonic shell dome-shaped and covered with several arrowhead-shaped granules; larval shell with two spiral cords intersected initially by granules, which gradually develop into axial ribs, interrupted at the boundary of the smooth spiral zone immediately above the adapical spiral cord; ~ 40 slightly sigmoid and discontinuous axial ribs. Teleoconch with up to 13 whorls; two main spiral cords (median and abapical) at the beginning, derived from the protoconch spiral cords, and a very small one (adapical) above, close to the median cord; adapical spiral cord gradually strengthens, becoming distinctive and nodulose at approximately the fourth or fifth whorl, reaching almost the same size as the abapical spiral cord between the eighth and tenth whorl; median spiral cord slightly more pronounced than the others; 15–18 narrow and slightly opisthocline axial ribs on the seventh whorl of the teleoconch; nodules of a medium size, almost round, partially cut by the spiral cords, mainly on median and abapical ones; shallow

but distinctive suture, with a small sutural cord; smooth subperipheral cord and two smooth basal cords, the abapical one very small; absence of supranumerical spiral cords at the end of the body whorl; aperture ovoid; anterior and posterior canals broken or not formed; thick inner lip. Light brown protoconch, white teleoconch.

Geographic distribution: Brazil: off Espírito Santo and Rio de Janeiro states.

Bathymetric distribution: 607–940 m.

Remarks: *Strobiligera delicata* sp. nov. is very similar to *Strobiligera georgiana* (Dall, 1927) comb. nov. and *Strobiligera indigena* (Dall, 1927) comb. nov., two species that are known only from Georgia, U.S.A. The lectotype of *S. georgiana* was designated by Rolán and Fernández-Garcés (2008) and it is illustrated herein (Fig. 1A) because this is the most similar species to *S. delicata*. The three species show the same color pattern—a white teleoconch with a beige/brown protoconch—in addition to slow development of the adapical spiral cord of the teleoconch and a rectilinear profile of the shell. The bathymetric distribution of *S. delicata* (607–940 m depth) overlaps with that of *S. georgiana* and *S. indigena*, which were recorded at 805 m depth. Unfortunately, the protoconchs of the type material of *S. georgiana* and *S. indigena* are at least partially eroded (Rolán and Fernández-Garcés 2008), hindering a detailed comparison with *S. delicata*, particularly on the embryonic shell. Dall (1927) described the embryonic shell of *S. georgiana* as being smooth (probably because it was worn) and the larval shell as possessing two spiral cords and "numerous retroactively [interrupted?] flexuous axial threadlets", just like in *S. indigena*, which coincides with the larval shell of *S. delicata* (Fig. 1I). Because of these similarities, we also consider *S. georgiana* and *S. indigena*, species of the West Atlantic with a multispiral protoconch, as representatives of *Strobiligera* (Table 1).

Compared to *Strobiligera delicata*, *S. georgiana* has a more conical shell, a later development of the adapical spiral cord and a reduced number of axial cords on the teleoconch (~ 12 axial cords on the seventh whorl of the lectotype of *S. georgiana*: Fig. 1A; 15–18 axial cords on the same whorl on *S. delicata*: Figs. 1B–1C). Compared to the lectotype of *Strobiligera indigena* (illustrated by Rolán and Fernández-Garcés 2008), *S. delicata* shows earlier development of the adapical spiral cord and less convex whorls on the teleoconch (Figs. 1B–1C). Also, *S. delicata* reaches up to 5.77 mm in length at 13 whorls of teleoconch (protoconch complete), which is considerably less than *S. georgiana* (lectotype measuring 7.5 mm at 13 whorls of teleoconch, protoconch incomplete) and *S. indigena* (lectotype measuring 6.6 mm at 11 whorls of teleoconch, apex missing).

Triphora caracca Dall, 1927, from Georgia (U.S.A), also shows the same coloration as *Strobiligera delicata*. However, *T. caracca* can be easily distinguished on the basis that its median spiral cord develops later, on the tenth whorl (Rolán and Fernández-Garcés 2008), a feature that makes it more similar to the genus *Monophorus* Grillo, 1877.

Etymology: the name of this species alludes to the delicate aspect of its shell.

Strobiligera inaudita (Rolán and Lee, 2008) comb. nov.

(Figs. 2A–2K)

Triphora sp.: Absalão *et al.* (2006: 238, *in part*).
Triphora inaudita Rolán and Lee *in* Rolán and Fernández-Garcés (2008: 150, figs. 26 A–D); García and Lee (2011).

Type material: holotype: FLMNH 419185. Paratype: BMSM 15203.

Type locality: 26°42.9′N, 83°43.2′O, 73.3–78.5 m, Dry Tortugas, Florida, U.S.A.

Material examined: the holotype, and, additionally, from Brazil: off Espírito Santo state: IBUFRJ 19504, REVIZEE C1 sta. VV38, 19°28′26″S,38°22′30″W, 71 m, 29.ii.1996 [1]; IBUFRJ 19613, REVIZEE C1 sta. VV38, 19°28′26″S,38°22′30″W, 71 m, 29.ii.1996 [1]; Campos Basin (off Espírito Santo and Rio de Janeiro states): IBUFRJ 19523, 20°47′S,40°26′W, Oc. ship Almirante Câmara coll., 29.viii.1979 [1]; IBUFRJ 19592, REVIZEE C1 sta. D3, 22°04′30″S,40°04′55″W, 98 m, 13.ii.1996 [1]; MNRJ 19478, 22°42′S,40°40′W, 110 m, 11.iv.2003 [4]; MNRJ 30870, 22°42′S,40°40′W, 110 m, 19.ix.2003 [1]; MNRJ 30905, 22°42′S,40°40′W, 110 m, 19.ix.2003 [1]; MNRJ 31106, 22°42′S,40°40′W, xi.2007 [1]; MNRJ 31125, 22°42′S,40°40′W, xii.2001 [1]; MNRJ 32348, 22°42′S,40°40′W, 110 m, ix.2004 [3]; IBUFRJ 11695, 22°48′S,40°45′W, 110 m, supply boat N/RB Astro Garoupa coll., 27.i.1998 [7]; IBUFRJ 19562, 22°48′S,40°45′W, 110 m, supply boat N/RB Astro Garoupa coll., iv.1998 [7]; MNRJ 18382, HAB 16 sta. C5-R1, 22°57′24″S,40°50′36″W, 142 m, 03.vii.2009 [1]; MNRJ 18971, 23°04′S,40°59′W, 17.xii.2004 [2]; MNRJ 18429, HAB 16 sta. B5-R3, 23°12′04″S,40°59′42″W, 142 m, 02.vii.2009 [1]; MORG 40691, Campos Basin [1]; MORG 40730, Campos Basin [1]; MORG 52230, Campos Basin, 2003 [1]; MORG 52234, Campos Basin, 2003 [1]; MORG 52237, Campos Basin [1]; MORG 52242, Campos Basin, 2003 [1].

Characterization: shell sinistral, slender, narrow, conical-fusiform, rectilinear in profile, attaining up to 8.00 mm in length, 1.80 mm in width. Protoconch columnar, 0.39–0.45 mm in length, 0.31–0.33 mm in width, 3.5–4 convex whorls; embryonic shell dome-shaped and covered with several arrowhead-shaped granules; larval shell with two

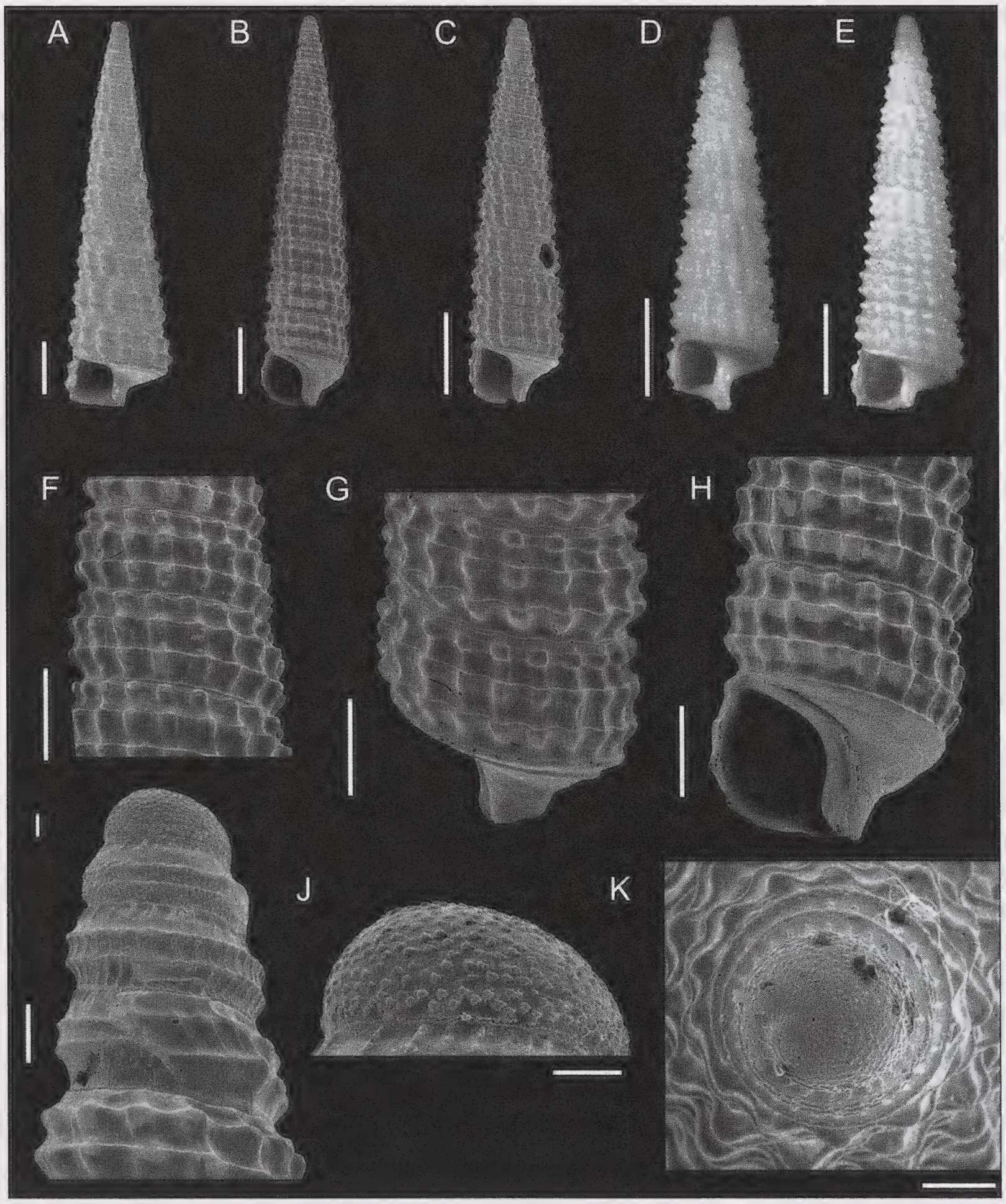

Figure 1. A, *Strobiligera georgiana* comb. nov. **B–K,** *Strobiligera delicata* sp. nov.; **A–E,** Entire shell, frontal view; **F,** detail of the teleoconch; **G,** abapical portion of the shell, dorsal view; **H,** abapical portion of the shell, frontal view; **I,** protoconch and initial portion of the teleoconch; **J,** embryonic whorl; and **K,** protoconch, adapical view. A, Lectotype USNM 333516; B, F, H–J, Holotype MNHN IM-2000-27528; C, G, K, Paratype MNRJ 25955. D–E, paratypes MNHN IM-2000-27529. Scale bars: A–E, 1 mm; F–H, 500 µm; I, K, 100 µm; J, 50 µm. (Color shown in electronic version only).

spiral cords intersected initially by granules, which gradually develop into axial ribs, interrupted at the boundary of the smooth spiral zone immediately above the adapical spiral cord; ~ 40 discontinuous axial ribs that vary from almost rectilinear to slightly sigmoid. Teleoconch with up to 15 whorls; two main spiral cords (median and abapical) at the beginning, derived from the protoconch spiral cords, and a very small one (adapical) above, close to the median cord; adapical spiral cord gradually strengthens, reaching the same size as the others between the ninth and tenth whorls; 16–18 nearly orthocline axial cords on the seventh whorl of the teleoconch; nodules of a medium size, rounded (particularly on the adapical spiral cord) to elliptic (particularly on the abapical spiral cord); shallow but distinctive suture, with a small sutural cord; weakly nodulose subperipheral cord, wavy adapical basal cord, slightly wavy to smooth abapical basal cord; supranumerical spiral cord at the end of the body whorl, between median and abapical spiral cords; oval aperture; short and open anterior canal, but crossed at its base by a projection of the outer lip; narrow and deep posterior canal, almost detached from aperture; thick inner lip. Light brown protoconch; teleoconch with the two initial whorls white; remaining whorls with a white median spiral cord, adapical and abapical spiral cords usually with one or two orange-brownish nodules intercalated with one or two white nodules; orange-brownish base.

Geographic distribution: U.S.A.: Florida (type locality), Louisiana (Rolán and Fernández-Garcés 2008); Brazil: off Espírito Santo and Rio de Janeiro states (present study).

Bathymetric distribution: 58 m (Rolán and Fernández-Garcés 2008)–142 m (present study).

Remarks: the holotype of *Strobiligera inaudita* (Fig. 2A) was examined, but with the shell already partially broken (protoconch detached from teleoconch). *Strobiligera inaudita* is easily distinguished from its congeners due to the radial coloration pattern of its teleoconch (Figs. 2A–2C), whereas other species of *Strobiligera* usually have a homogeneously colored teleoconch. *Strobiligera flammulata* Bouchet and Warén, 1993, from the Northeast Atlantic and Mediterranean, has an axial pattern of coloration, with brown blotches on the three spiral cords, rather than a white median spiral cord as in *S. inaudita*.

Despite being represented in collections only by empty shells, *Strobiligera inaudita* seems to be restricted to deeper layers of the continental shelf from 58–142 m (Rolán and Fernández-Garcés 2008; Garcia and Lee 2011; present study).

Table 1. Updated list of species assigned to *Strobiligera*.

Species	Protoconch	Geographic distribution	Bathymetric distribution
Strobiligera brychia (Bouchet and Guillemot, 1978)	Multispiral	Northeast Atlantic, Mediterranean*	140–2220 m*
Strobiligera lubrica Bouchet and Warén, 1993	Multispiral	Northeast Atlantic*	2000 m*
Strobiligera flammulata Bouchet and Warén, 1993	Multispiral	Northeast Atlantic, Mediterranean*	75–545 m*
Strobiligera delicata sp. nov.	Multispiral	Southeastern Brazil**	607–940 m**
Strobiligera inaudita (Rolán and Lee, 2008) comb. nov.	Multispiral	Southern U.S.A., Southeastern Brazil**	58–142 m**
Strobiligera georgiana (Dall, 1927) comb. nov.	Multispiral	Georgia (U.S.A.)***	805 m***
Strobiligera indigena (Dall, 1927) comb. nov.	Multispiral	Georgia (U.S.A.)***	805 m***
Strobiligera ibex (Dall, 1881)	Paucispiral	Gulf of Mexico***	823–1189 m***
Strobiligera bigemma (Watson, 1880)	Paucispiral	Culebra island (Puerto Rico)***	713 m***
Strobiligera inflata (Watson, 1880)	Paucispiral	Culebra island (Puerto Rico)***	713 m***
Strobiligera compsa (Dall, 1927) comb. nov.	Paucispiral	Georgia (U.S.A.)***	805 m***
Strobiligera enopla (Dall, 1927) comb. nov.	Paucispiral	Florida (U.S.A.) and Cuba***	538–823 m***
Strobiligera meteora (Dall, 1927) comb. nov.	Paucispiral	Florida (U.S.A.)***	538 m***
Strobiligera pompona (Dall, 1927) comb. nov.	Paucispiral	Georgia (U.S.A.)***	805 m***
Strobiligera dinea (Dall, 1927) comb. nov.	Paucispiral	Georgia (U.S.A.)***	805 m***
Strobiligera sentoma (Dall, 1927) comb. nov.	Paucispiral	Florida (U.S.A.)***	538 m***
Strobiligera gaesona (Dall, 1927) comb. nov.	Paucispiral	Georgia (U.S.A.)***	805 m***

* based on Bouchet and Warén (1993)
** based on the present study
*** based on Dall (1927) and Rolán and Fernández-Garcés (2008)

The upper limit of this bathymetric range basically corresponds to the supposed limit of 60 m below which initiates the twilight zone (Pyle 2001). This limit marks an apparent transition in the species composition of triphorids (Albano *et al.* 2011), more or less related to specific kinds of sponges, which are their source of food.

The discontinuous geographic distribution of *Strobiligera inaudita*, with isolated records from Southern U.S.A. and Southeastern Brazil, and apparent absence from the Caribbean, is probably due to its recent description and the reduced number of dredgings at the bathymetric range of this species.

DISCUSSION

The type species of *Strobiligera*, *Strobiligera ibex* (Dall, 1881), was described as having a paucispiral protoconch with a smooth and inflated first whorl that is much larger than the subsequent whorl [these features were cited by Dall (1924) in his description of *Strobiligera* as a subgenus of *Triphora* Blainville, 1828]. This type of protoconch (Fig. 3A) is very different from that of the type species of *Inella*, *Inella gigas* (Hinds, 1843), which has a distinctive paucispiral protoconch with well-defined spiral cords and no axial sculpture (Marshall 1983: figs. 10 D, H); Fig. 3B shows a typical (in the sense of the type species) protoconch of *Inella*. For this reason, we agree with Bouchet (1985) and Bouchet and Warén (1993) in considering *Strobiligera* as a valid genus.

The embryonic shell of a multispiral protoconch in *Strobiligera* can be covered with cruciform granules, as in *Strobiligera flammulata*, or with arrowhead-shaped granules, as in *Strobiligera brychia* (Bouchet and Guillemot, 1978), *Strobiligera delicata* (Fig. 1J) and *Strobiligera inaudita* (Fig. 2J). The arrowhead-shaped granules appear to be a variation of the cruciform granules.

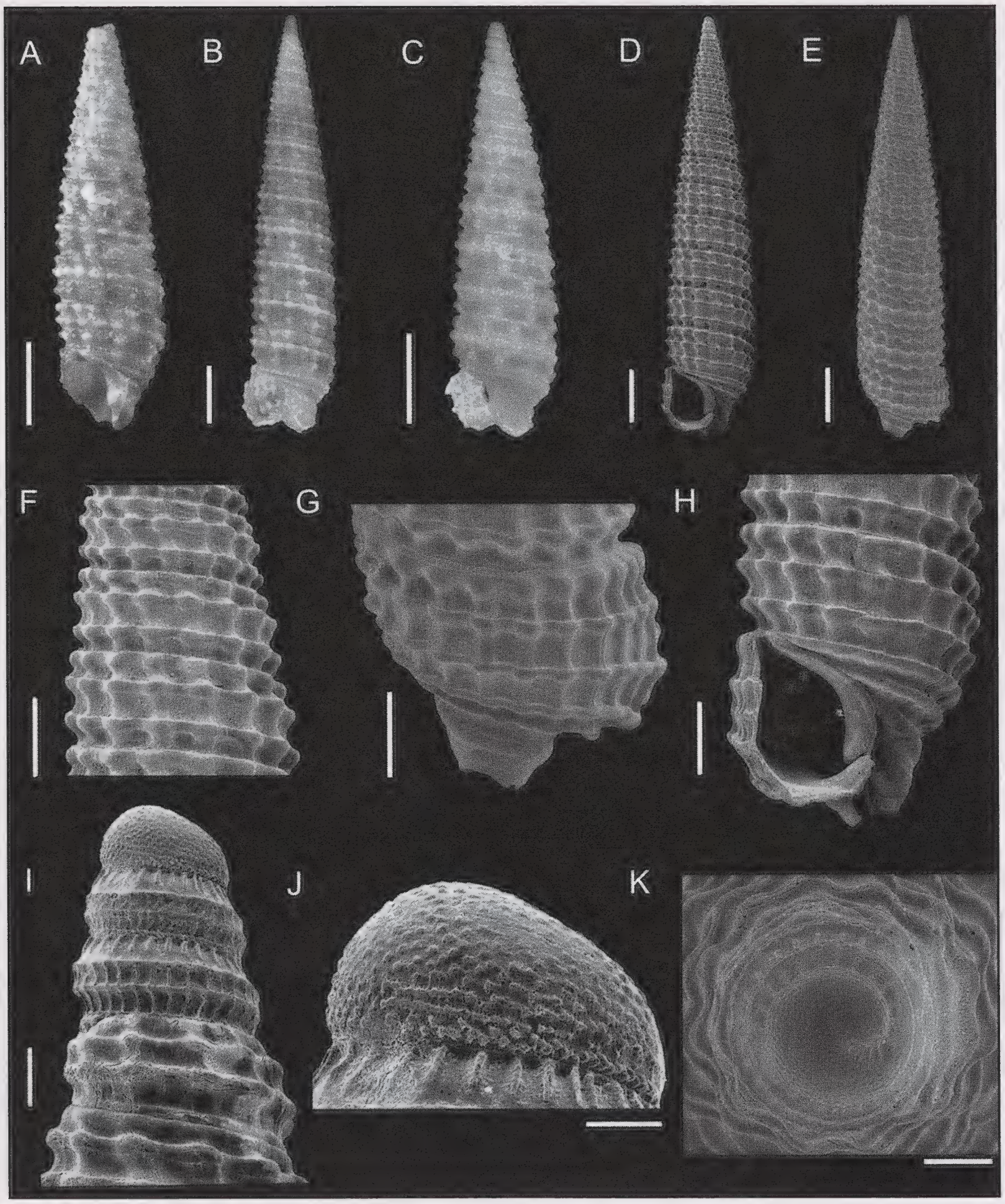

Figure 2. *Strobiligera inaudita* comb. nov. **A–D,** Entire shell, frontal view; **E,** entire shell, dorsal view; **F,** detail of the teleoconch; **G,** abapical portion of the shell, dorsal view; **H,** abapical portion of the shell, frontal view; **I,** protoconch and initial portion of the teleoconch; **J,** embryonic whorl, and **K,** protoconch, adapical view. **A,** Holotype FLMNH 419185; **B,** IBUFRJ 19562; **C–K,** IBUFRJ 11695. Scale bars: A–E, 1 mm; F–H, 500 μm; I, K, 100 μm; J, 50 μm. (Color shown in electronic version only).

Regarding the sculpture of the teleoconch, the type species *Strobiligera ibex* (illustrated in Rolán and Fernández-Garcés 2008) possesses two evident spiral cords. However, according to Dall (1924, 1927), the concept of *Strobiligera* mainly comprises species with three spiral cords [*e.g., Strobiligera dinea* (Dall, 1927) comb. nov.; *Strobiligera meteora* (Dall, 1927) comb. nov.], even when the adapical one is very small [*e.g., Strobiligera enopla* (Dall, 1927) comb. nov.; *Strobiligera pompona* (Dall, 1927) comb. nov.], thus resembling *S. ibex.*

The diagnosis of *Strobiligera* provided herein addresses the aforementioned issues regarding teleoconch and protoconch morphology, besides radular features of species with a multispiral protoconch (Bouchet 1985, Bouchet and Warén 1993). However, the inclusion of species with a multispiral protoconch in *Strobiligera* cannot be considered as definitive, as there are no available descriptions of soft parts of any *Strobiligera* species with a paucispiral protoconch (including *Strobiligera ibex*), thus precluding further comparisons. As it seems difficult to obtain radulae of *S. ibex* and its deep-sea congeneric species with a paucispiral protoconch, combined with the geographical proximity with those species possessing multispiral protoconch and herein also treated as *Strobiligera*, we prefer not to create a new genus to accommodate the species with multispiral protoconch, but to follow the broad concept of *Strobiligera* by Bouchet (1985) and Bouchet and Warén (1993).

In the present work, we update the number of species of *Strobiligera*, transferring some Caribbean species currently allocated to *Inella* and *Triphora* to this genus (Table 1). Partially, we followed Dall (1927), who considered some of these species as belonging to the theretofore subgenus *Strobiligera*. The records of *Strobiligera pompona* (Dall, 1927) comb. nov. and *Strobiligera compsa* (Dall, 1927) comb. nov. to Brazil [Rios (2009) and Absalão (1989), respectively] are misidentifications and do not belong in *Strobiligera* (M. R. Fernandes, pers. obs.). Their correct taxonomic allocation will be provided in a subsequent paper.

Strobiligera seems to be essentially from deep waters, as indicated by Dall (1924) and Bouchet (1985). The species occurring at the shallowest depths are *Strobiligera inaudita* (up to 58 m), *Strobiligera flammulata* (up to 75 m), and *Strobiligera brychia* (up to 140 m; however, living specimens have been recorded as deep as 850 m). The remaining species range from 538 m (*Strobiligera enopla* and *Strobiligera meteora*) to 2000 m (*Strobiligera lubrica*) (Table 1), indicating a major presence on the continental slope. Although most of these species are known only by empty shells, we discard the hypothesis of a generalized vertical distribution *post mortem* that would alter radically the original bathymetric range of all the 17 species in *Strobiligera* (Table 1).

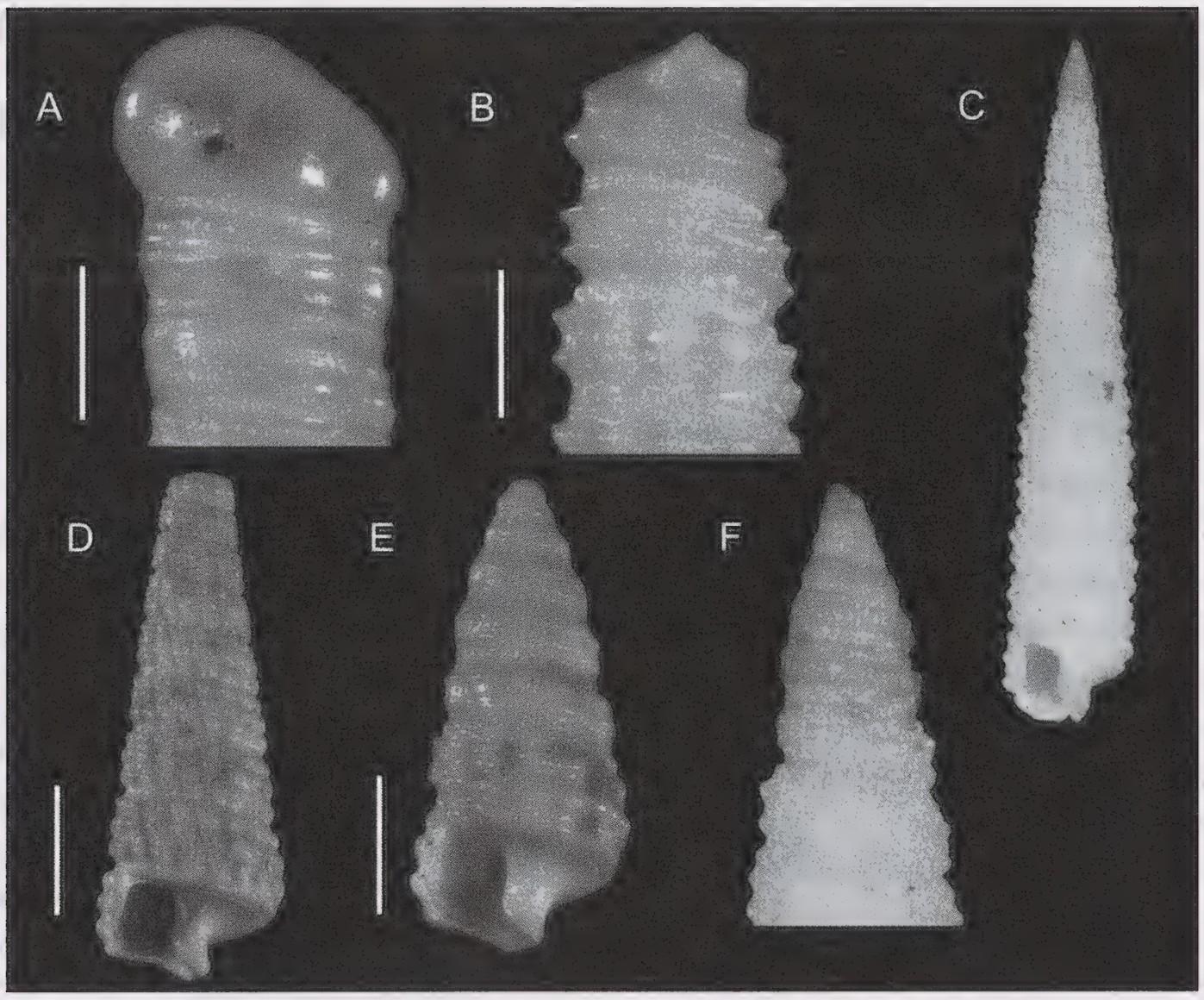

Figure 3. A, A typical protoconch of *Strobiligera*, like its type species (*S. ibex*); **B,** a typical protoconch of *Inella*, like its type species (*I. gigas*); **C, F;** *Subulophora exporrecta*. **D–E,** *Norephora granulata*. **C, F,** Holotype AMS C.8525. **D,** BGR 1430. **E,** BGR 1432. Scale bars: A–B, E, 500 µm; D, 1mm. (Color shown in electronic version only).

Other genera of the *Inella* group share some similarities with *Strobiligera*. Rolán and Fernández-Garcés (1994) indicated the presence of arrowhead-shaped granules on a species of the genus *Monophorus*; other species within this genus have cruciform granules, just like *Strobiligera*. However, *Monophorus* can be distinguished from *Strobiligera* by the later development of the median spiral cord, whereas in *Strobiligera* the adapical spiral cord is initially reduced.

A very similar genus to *Strobiligera* is *Subulophora* Laseron, 1958, whose Recent species are restricted to the Indo-Pacific, including the type species *Subulophora exporrecta* Laseron, 1958, a junior synonym of *Subulophora rutilans* (Hervier, 1897), according to Marshall (1983). The teleoconch (with an initially reduced adapical spiral cord) and protoconch [embryonic shell with cruciform tubercles, larval shell with a smooth spiral zone above the adapical spiral cord; also, see the description of *S. rutilans* by Marshall (1983)] of *S. exporrecta* (Figs. 3C, 3F) are similar to species of *Strobiligera* with a multispiral protoconch. However, the protoconch of *Subulophora* has an acuminated apex (Fig. 3F), instead of the dome-shaped apex of *Strobiligera* (Figs. 1I, 2I). Furthermore, the adapical spiral cord of the teleoconch of *Subulophora* (Figs. 3C, 3F) develops much faster than that of *Strobiligera* species (Figs. 1A–1E, 2B–2E). Marshall (1983) also stated that *Subulophora rutilans* and *Strobiligera brychia* have similar teleoconchs, but their radulae [that of *S. rutilans* illustrated by Marshall (1983), that of *S. brychia* by Bouchet (1985)] were quite different in number and relative size of cusps of each tooth, and considered it to be "impossible to ascertain the significance of the differences". We think that their radulae are very different, which increases our confidence in treating them as separate genera.

The fossil genus *Norephora* Gründel, 1975, restricted to Europe, is also similar to *Strobiligera* species with multispiral protoconch. However, the same features used to separate *Subulophora* from *Strobiligera* can be applied to *Norephora*, which raises the assumption of *Norephora* being a synonym of *Subulophora*, pending further investigation. The type material of the type species *Norephora granulata* (Strauch, 1967) is missing (Dr. Michael Amler, pers. comm.), so we illustrate herein the material originally studied by Gründel (1975) when establishing *Norephora* (Figs. 3D–3E).

The number of recognized and named triphorid species in Brazil is currently at 26 (based on Fernandes *et al.* 2013), which includes the two *Strobiligera* species examined herein and excludes the records of *Strobiligera compsa* and *Strobiligera pompona*, as mentioned above. Further studies are needed on the alpha-taxonomy of triphorids from Brazil, including a large revision of the group *Inella s.l.*

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